

# Utah Science

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Spring 1991

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# UTAH SCIENCE

UTAH STATE UNIVERSITY

AGRICULTURAL EXPERIMENT STATION

VOLUME 52 SPRING 1991 NUMBER 1

*Spring*

# UTAH SCIENCE

UTAH AGRICULTURAL EXPERIMENT STATION  
UTAH STATE UNIVERSITY  
LOGAN, UTAH 84322-4845

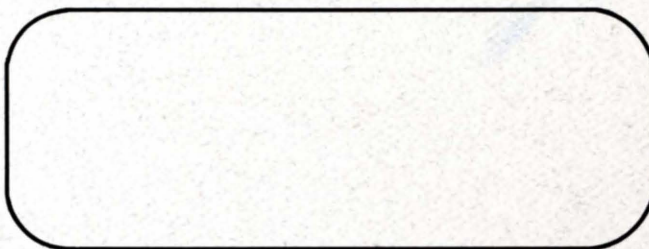
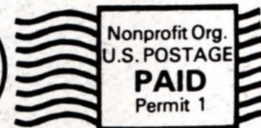
*Paul S. Hansen*

DIRECTOR

Address Correction Requested



UTAH STATE UNIVERSITY





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Stanford Cazier  
PRESIDENT, UTAH STATE UNIVERSITY

Doyle J. Matthews  
DEAN OF AGRICULTURE

H. Paul Rasmussen  
DIRECTOR, AGRICULTURAL EXPERIMENT STATION

Kurt W. Gutknecht  
EDITOR

Holly Broome-Hyer  
GRAPHIC ARTIST

Gary Neuenswander  
MEDIA SPECIALIST

Contributors to this issue:  
Lynnette Harris, Science Writer, USU  
Information Services.

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# UTAH SCIENCE

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SPRING 1991 1



# A Message (Sort Of) from the DIRECTOR

"Spring!" H. Paul Rasmussen thundered.

"It makes me glad to be alive. I want to soak it all up—the sun, the sky, the soil.

"It makes me... it makes me..." And as if he were embarrassed, he suddenly fell silent, pondering the gloom of a February winter.

"Warm?" Gary volunteered hopefully. "It makes you feel warm?"

"Dirty? Holly said. "I always seem to get dirtier in the spring."

Paul glowered. We cowered. We had never seen him so agitated.

Gary snuffled. Holly pulled on a loose thread. I looked at my shoe laces.

"Does spring make you wet? It seems to rain more in the spring," I croaked. Paul looked at me with thinly veiled disgust.

After what seemed to be an interminable wait, he started talking again, this time quietly but with conviction. There was a small cowlick in the back of his head. I did not think it wise to

point out that the cowlick made him look like a radish with glasses.

"I want the next issue of *Utah Science* to reflect the exuberance of spring," he said. "Take risks. Get our readers' blood roiling. Kick over the traces. Just do it. Now get out of here." And he turned to the papers on his desk.

"And stop sniveling," he said before we were out of earshot.

Of course, Paul said none of this, but he *could* have. We decided that the spring of 1991 was special, and deserved a special issue. The pulse quickens as the day lengthens and the tentacles of winter recede.

Others have described spring better than we ever could. Still, agricultural researchers have a very special relationship with this annual renewal of life. What they do is important. And special.

And often, very spring-like indeed.





# TAKE THIS TEST

## IF YOU WANT PLANTS TO THRIVE



**S**tatistics are hard to come by, but only a small percentage of the farmers and gardeners in the state have their soil tested. And it's no laughing matter. Hundreds of thousands of dollars in fertilizer is wasted annually. Tomatoes and broccoli falter in mid season. Wheat and alfalfa yields plummet, all because plants lack the right nutrients.

It's a shame because the problem is so easy and inexpensive to correct, says Janice Kotuby-Amacher, supervisor of the USU Soil Testing Laboratory. County Extension offices have information on proper sampling techniques. The rest is easy: Just mail samples to the lab and wait for the results, which are usually mailed within five working days after samples are received.

"Our philosophy is different from some other soil testing labs. We provide cost-effective recommendations based on the nutrients available in the soil. Others might try to replenish all nutrients taken up by the plant and not worry about nutrients provided by the soil," Kotuby-Amacher says. The USU lab makes sure the cost of

fertilizer doesn't exceed the value of the additional yield. Some other labs base recommendations on maximum yields.

Another advantage: The USU lab lets you select only those tests that you need. Some labs only offer a package of tests, whether or not you need them.

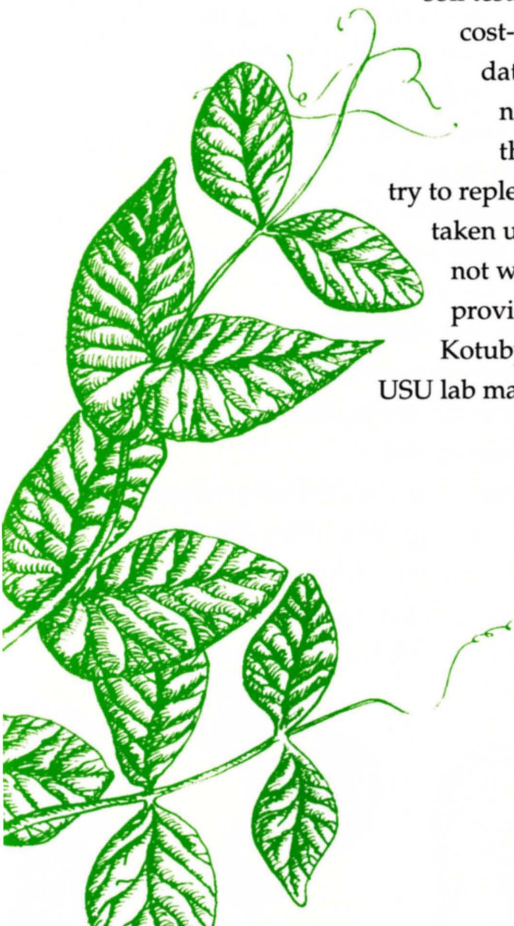
The USU lab also tests feed, water and plant tissue. Kotuby-Amacher notes that soil samples are not routinely tested for nitrogen because results depend on how samples are handled (samples tested for nitrogen should be kept cold or dried immediately). Also, testing nitrogen in the fall may not accurately indicate how much nitrogen will be available in the spring. Instead, nitrogen recommendations are based on crop history.

Test results are accurate. The USU lab cooperates with about 50 other labs in a program to monitor the consistency and accuracy of testing, and follows a rigorous quality assurance/quality control (QA/QC) program, including participation in the U.S. Environmental Protection Agency's QA/QC program for water and wastewater analysis. The lab is also EPA certified.

Every garden is planted with generous amounts of hope. Soil tests can make those hopes come true.

KG

Janice Kotuby-Amacher 750-2217







Reduce

# LEACHING

to Save Water

**H**ow much leaching is necessary to prevent salt buildup in the root zone?

Perhaps much less than once thought. If so, farmers could reap substantial savings in water and significantly reduce the risk of groundwater pollution, say Lynn Dudley, USU soil chemist, and John Hanks, USU soil physicist.

The tactic could save irrigators a passel of trouble later on.

Research plots at Huntington, Utah, provide convincing evidence that leaching can be reduced. At this site, USU researchers have been applying saline wastewater from a power plant to research plots for 14 years—with *no* leaching whatsoever. Salt levels in the root zone have not yet increased enough to affect forage yields.

Why the apparent disparity between recommended intervals between leaching and the results at Huntington? Dudley says it may reflect the fact that recommendations are based on lysimeters and

greenhouse studies. Plants in the field seem to fare better with longer intervals between leaching than these studies indicate. "Under certain conditions annual leaching is not required and may even be postponed for years," Dudley says. "The calcium and sulfate salts in some irrigation water precipitate in the soil as gypsum and will never hurt plant yields. Chlorides and other soluble salts, which don't precipitate, must be removed."

The trick is to apply just enough irrigation water to leach soluble salts from the root zone, but not so much that all salts and other undesirable chemicals are flushed into the groundwater.

Dudley is analyzing models of salt transport and chemistry, which irrigation engineer Richard Peralta will use to develop an irrigation scheme for optimum yields. The resulting irrigation scheme may involve some reduction in yield, but could reduce





# Learning About LEACHING

The less water, the less leaching.

That makes sense, but it may not make any difference unless it's proven.

Farmers are likely to hear a lot more about groundwater quality in the next few years, particularly about possible contamination from fertilizers, pesticides and other agricultural inputs. A major concern is nitrates that may leach from nitrogen fertilizers.

Water-quality regulations have tended to be based on conditions in the Midwest or Pacific Northwest, which often receive more than 40 inches of rain annually. In Utah, where relatively little rain falls during the growing season, snowmelt and irrigation may contribute more to leaching than rainfall, says USU soil scientist Phil Rasmussen.

Maybe. Speculation doesn't count for much when regulations are being drafted, which is why Rasmussen is monitoring leaching under several plots at the Greenville Experimental Farm to determine the effects of irrigation level, different crops and tillage practices. Leaching under grass plots, which is similar to leaching under rangelands, is also monitored. The study will continue for 10 years, and perhaps longer.

"When national policies are established, we want to have some data on leaching in Utah that farmers can use in their self-defense," Rasmussen says. "So far, we've detected no difference in leaching from various plots, and there appears that there's little leaching from dryland crops."

KG

Phil Rasmussen 750-2257

irrigation requirements by 20 percent, as well as protecting groundwater quality. Keeping nitrogen in the root zone where it can be used by plants is an additional benefit.

A longer interval between leaching could stave off the need to impose far more stringent options to protect groundwater quality. In some areas of California where salinity is defined as a pollutant, irrigators must collect salt-laden drainage water and direct it to evaporation ponds to remove salt.

The research is sponsored by the Utah Agricultural Experiment Station and the Cooperative State Research Service (USDA).

KG

Lynn Dudley 750-2184

John Hanks 750-2175

Richard Peralta 750-2786





*Calochortus nuttallii*

# SEGO LILY

Propagated  
As Ornamental Plant

**T**he showy Segoe lily may move down from the mountain.

USU researchers are trying to propagate the drought-hardy state flower as an ornamental plant. It's nearly impossible to propagate from seed, but researchers can produce about 50 bulbs by culturing the tissue from one plant; there's enough material in each of these bulbs to culture an additional 10 bulbs.

The problem is getting bulbs to produce roots and shoots, says plant scientist John Carman. Segoe lilies enter a rest period for a few weeks in the summer, produce a flush of growth in the fall, and then remain dormant through the winter. To encourage lab-produced bulbs to sprout, they must simulate the summer rest period by drying bulbs for several weeks. Unfortunately, the artificial drought kills most of the bulbs.

The propagation system must be refined to produce healthier bulbs before Segoe lily plantlets or bulbs are ready for commercial production.

"Segoe lilies are very showy, particularly when planted in groups," says USU horticulturist William Varga, who is studying the phenology of the lily to determine what initiates flowering. Varga says the lilies aren't endangered, although development on foothills is removing their most visible habitat. Segoe lilies flourished during last decade's wet spell. "Thousands emerged in locations where there were once were only a dozen or so," Varga says.

With some additional research, the state flower may also grace thousands of home gardens.

KG

John Carman 750-2238

Bill Varga 750-2099

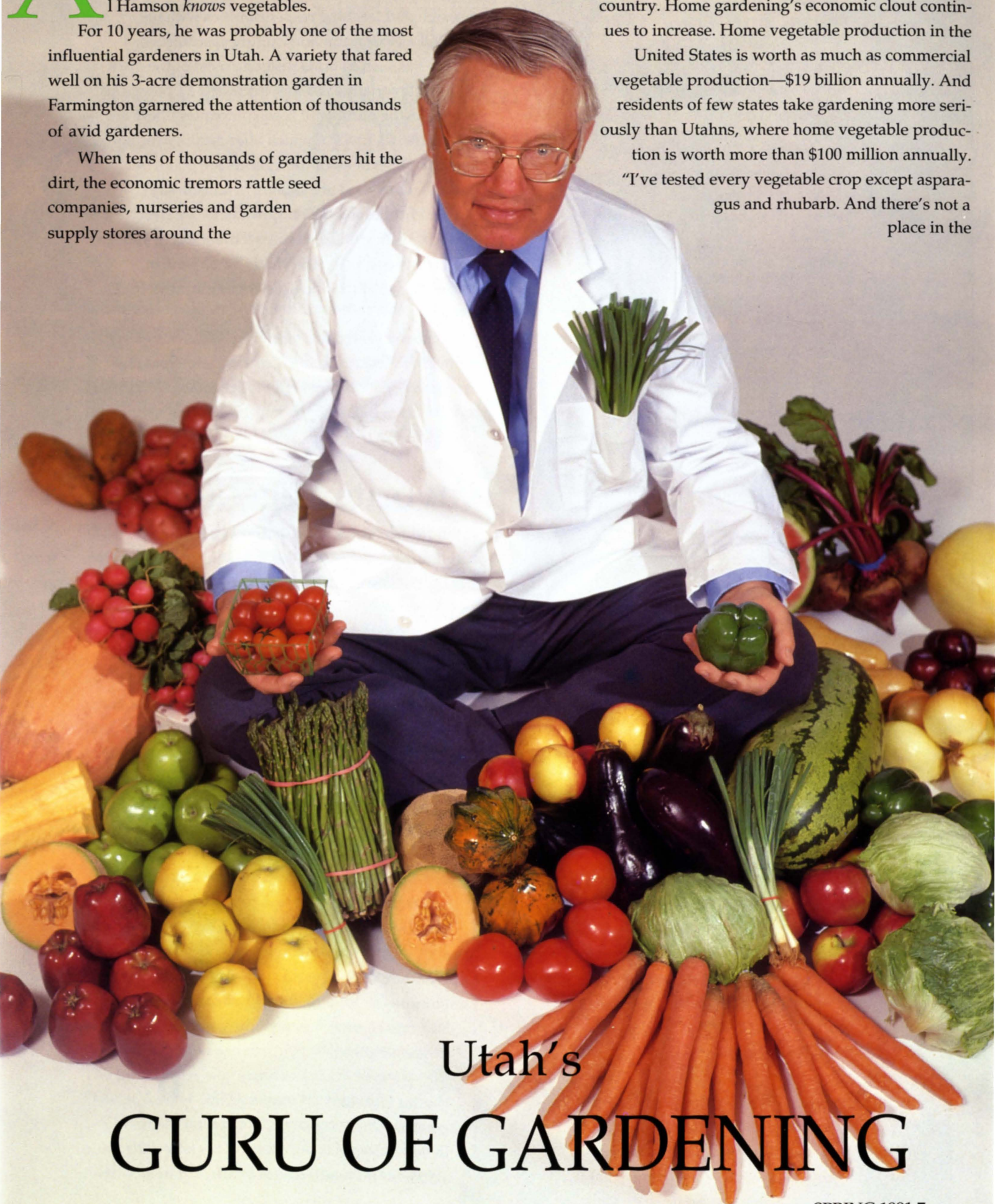


**A**l Hamson *knows* vegetables.

For 10 years, he was probably one of the most influential gardeners in Utah. A variety that fared well on his 3-acre demonstration garden in Farmington garnered the attention of thousands of avid gardeners.

When tens of thousands of gardeners hit the dirt, the economic tremors rattle seed companies, nurseries and garden supply stores around the

country. Home gardening's economic clout continues to increase. Home vegetable production in the United States is worth as much as commercial vegetable production—\$19 billion annually. And residents of few states take gardening more seriously than Utahns, where home vegetable production is worth more than \$100 million annually. "I've tested every vegetable crop except asparagus and rhubarb. And there's not a place in the



# Utah's GURU OF GARDENING



# Keep Gardening RECORDS

Which tomato varieties did you plant last year? When did you plant your peas and when did you begin harvesting them? How did you rid your pole beans of pests?

Most gardeners probably can't answer questions like these, but it would help if they could, says USU horticulturist Larry Rupp.

Recording even the most obvious factors—the type and location of varieties, whether seeds or starts were used, and irrigation schedules—will help. Also record what types of fertilizers, pesticides or other agents you applied. Note which insects and weeds were troublesome.

"Even the best varieties won't perform well if they are not properly cared for or planted in the right place," Rupp says. Keeping and reviewing good records can make sure you don't blame a cultivar for an environmental problem.

Also note how produce was processed and which varieties gave the best results. Your garden observations doesn't require special testing—simply record what you see and taste.

Noting that a particular variety tended to produce split fruit or needed more or less water will prevent you from repeating mistakes, Rupp says.

LH

Larry Rupp 750-2099



research and teaching responsibilities with his position as Extension horticulture specialist.

He has seen hybrids dislodge most of the open-pollinated varieties and has witnessed a precipitous decline in the number of seed companies (there are now about 60, most of which offer catalogs for home gardeners). "Not all of the hybrids are good, but those that are good are superb," Hamson says.

He encouraged melon growers to use clear plastic mulch, which increases temperatures and controls weeds, increases yields by 20 percent, conserves moisture, and accelerates maturity by 30 days.

Hamson retired last year from USU, but will funnel more energy into his real vocation and avocation—gardening. Plenty of vegetables will take root on his one-half acre home garden this spring.

## Favorite Vegetables

Alvin Hamson says he "usually goes for vegetables with unusual qualities." The following selections are among his conventional favorites.

**Carrots** (These varieties contain high levels of provitamin A carotenoids)

A+Hybrid

Ingot Hybrid

Lindoro Hybrid

**Cucumbers** (mild-flavored, easily digestible and never bitter)

Euro-American Hybrid

Sweet Success Hybrid

Jet Set Hybrid

**Sweet Corn**

Sugar Buns Hybrid

Miracle Hybrid

**Broccoli**

Premium Crop Hybrid

**Cantaloupe**

Summet Hybrid

Mission Hybrid

Rocky Sweet

Westar Hybrid

**Watermelon**

Crimson Sweet

Triple Sweet Seedless

world that I haven't tested seed from, except Australia, which didn't seem to offer much in the way of seeds," Hamson says. Initially, he had to solicit seeds from companies. That changed when seed companies that once catered exclusively to commercial growers saw the potential in home gardens.

Hamson's advice has been widely disseminated via radio, newspaper columns and Extension publications. People still corral him on the street and grill him about gardening.

Hamson joined USU in 1955 after earning his PhD at Cornell, where he was a member of the faculty for four years. Since 1972, he coupled his



# NewHy:

## New Saline-Tolerant Grass Hybrid Produces High-Quality Forage

**C**ertified seed of NewHy, a cross between bluebunch wheatgrass and quackgrass, will be available for purchase by farmers this fall.

The new variety's biggest attribute may be its tolerance to salinity, which it acquired from quackgrass. "It's about as salt-tolerant as tall wheatgrass and not quite as drought hardy as crested wheatgrass," says Kay Asay, plant breeder with the USDA's Forage and Range Research Laboratory in Logan. It should do well on irrigated sites or rangelands receiving at least 13 inches of precipitation annually.

The variety was released last year by the USDA Agricultural Research Service, the Utah Agricultural Experiment Station, and the Soil Conservation Service. Four growers purchased foundation seed and planted 32 acres of the new variety. Depending on growing conditions, between 5,000 and 10,000 pounds should be available to farmers, says Stan Young, secretary-manager of the Utah Crop Improvement Association. Young says price may range between \$2.50 to \$5.00 per pound.

A small amount of foundation seed for spring 1991 planting is available. There should be an ample supply of foundation seed this fall at \$12.50 per pound.

Breeders made sure that the new hybrid had none of quackgrass's undesirable attributes, such as aggressive vegetative spread via rhizomes. It does, however, produce moderate rhizomes. NewHy combines the bunch-type development, drought resistance and forage quality of bluebunch wheatgrass with the persistence, durability, productivity, and salinity tolerance of quackgrass. The initial cross was made in 1962 by Douglas Dewey, former USDA research geneticist.

Because NewHy and quackgrass seed look alike, the variety is protected. It is legal to sell and distribute only certified seed of the new variety.

For information about purchasing foundation or certified seed, contact Young, UCIA, Utah State University, Logan, UT 84322-4855.

KG

Kay Asay 750-3069  
Stanford Young 750-2082

## Experiment Station Tests New SWEET CHERRIES

Yum.

If all goes according to schedule, new juicy, red sweet cherries developed at the Utah Agricultural Experiment Station should be patented and available to growers in about 5 years. The cherries should be available to consumers about 5 years after they are released as new varieties.

Four cultivars have passed the final stages of evaluation at USU's Kaysville research orchard and are now being evaluated in the Northwestern U.S. and in Europe to determine how they fare under different growing conditions and during harvesting and processing, says Sherman Thomson, USU plant pathologist.

The new cultivars couple resistance to Western X disease with sweetness, color and size that are better than the popular Bing cherry, and the varieties previously released by the Experiment Station (Angela, Sweet Ann and Utah Giant). Thomson says the quality of fruit from the new cultivars is "outstanding."

Western X disease kills all of the currently grown varieties of sweet cherries. The disease is a major reason for the decline in sweet cherry production along the Wasatch Front.

KG

Sherman Thomson 750-3406



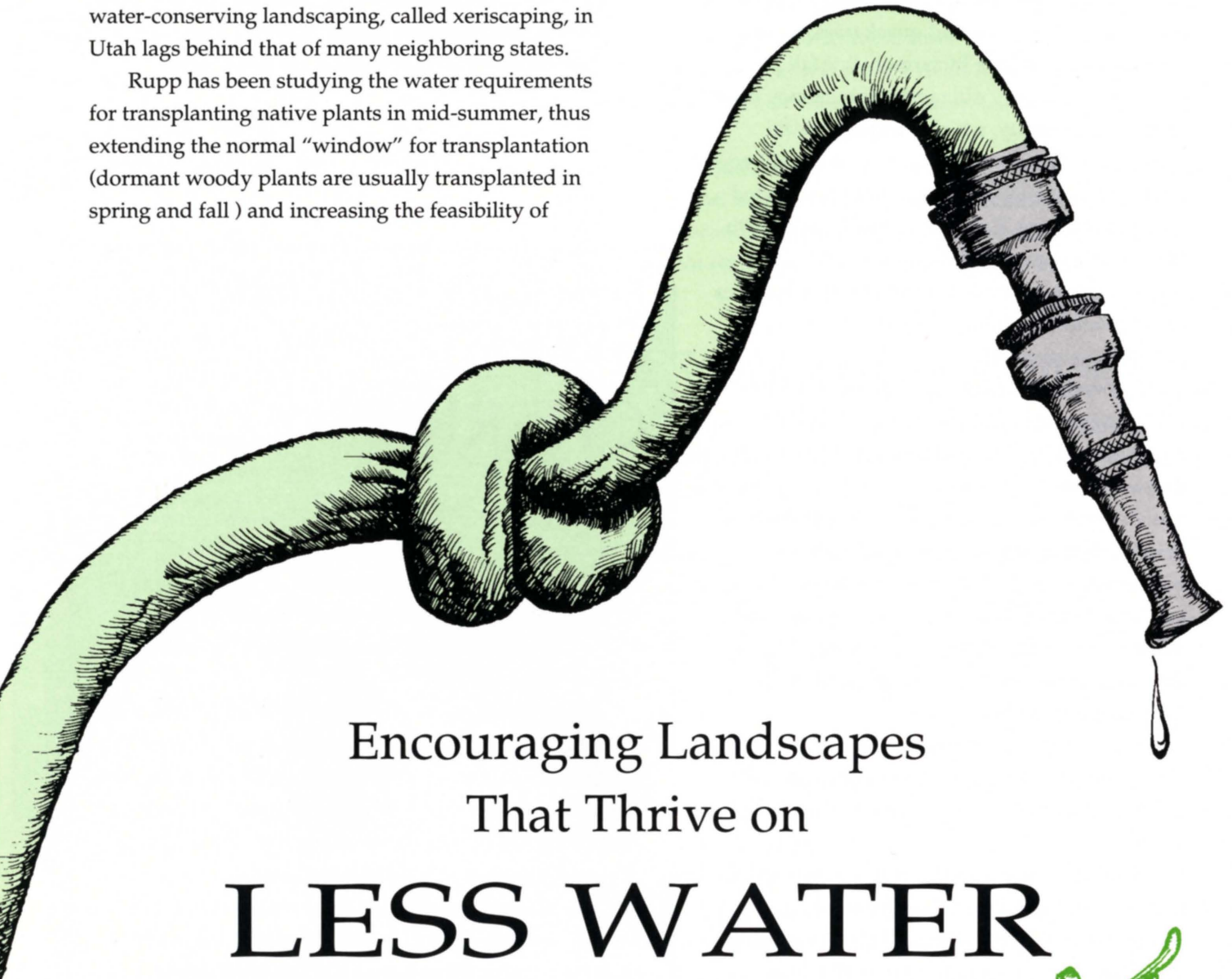
# F

or the second driest state, we have some mighty wet landscapes. Fortunately, that's changing.

There's been a slow but steady increase in the popularity of water-conserving landscapes in the state, a change prompted by the drought and encouraged by several cities and water districts, says Larry Rupp, USU horticulturist. Still, interest in water-conserving landscaping, called xeriscaping, in Utah lags behind that of many neighboring states.

Rupp has been studying the water requirements for transplanting native plants in mid-summer, thus extending the normal "window" for transplantation (dormant woody plants are usually transplanted in spring and fall ) and increasing the feasibility of

using these plants in low-maintenance landscapes. With modest irrigation, container-grown silver sagebrush, curly-leaf mountain mahogany, rubber rabbitbrush, red-stemmed dogwood, and chokecherries survived transplantation in July. Only oceanspray failed to survive on a site where soil and



## Encouraging Landscapes That Thrive on **LESS WATER**



other conditions at the site were far more favorable than on rangelands.

Ironically, Rupp says more is known about the water requirements of native plants than of plants traditionally used in landscaping. Rupp is summarizing research on the water requirements of woody plants for the U.S. Bureau of Reclamation so the agency can identify drought-tolerant species and promote their use in water-conserving landscapes.

A lot is being done in the state to slake the thirst of landscapes.

Park City is developing a demonstration xeriscape garden and offers substantial rebates on water hookup fees to homeowners and businesses that plant approved drought-tolerant landscapes. The Salt Lake City Water Reclamation Division has hired an engineering firm to assist in a freeway irrigation demonstration project using reclaimed waste water. This effluent is now simply dumped into the Great Salt Lake. As long as effluent isn't directly applied to foliage, the nutrients it contains should benefit plants, Rupp says, resulting in highway beautification without affecting current water supplies.

The Metropolitan Water District of Salt Lake City is establishing a drought-tolerant landscape at one of its storage sites. Rupp notes that water districts are in the incongruous position of encouraging actions that reduce demand for water, thus reducing potential income. However, as demand for water along the Wasatch Front threatens to outpace supplies, it doesn't appear that xeriscaping will seriously erode the income of these utilities.

Water utilities in some areas of California in the grip of a 6-year drought have offered hefty incentives to encourage water conservation, including a free exchange of water-conserving toilets for water-hogging johns that required several gallons of water per flush. (The old toilets can be dumped in the ocean to construct artificial reefs or crushed and used in road construction.)

California is also in the forefront of a water-conservation program in which water audits conducted on commercial and large-scale landscapes ensure the efficient use of water.

While water-conservation efforts in Utah have

so far been voluntary and low key, Rupp thinks xeriscaping and other water-conservation tactics are "on the verge of taking off in the state. And we are in a good position to learn from the successes and failures of other states. Our primary goal is to promote the wise use of water in landscaping so that we can maintain aesthetically pleasing and enjoyable landscapes even if there are water shortages."

A shortage of water could spur interest in native plants and increase demand for the services of trained horticulturists. Rupp says residents of the state could reap considerable benefits from both trends.

KG

Larry Rupp 750-2099





# Breeding Small Grains: FIRST YOU COMBINE GENES, THEN YOU UNRAVEL THEM

**R**ulon Albrechtsen is very patient.

It comes with his job. It's not that he isn't busy, it's just that it takes a long time to get the job *done*.

Usually more than a decade.

Wade Dewey also didn't expect instant gratification from his job.

No matter. Dewey, who retired last year after 33 years as winter wheat breeder, and Albrechtsen, who has bred spring wheat and barley at USU for 21 years, can claim credit for many of the wheat and barley varieties grown in the Intermountain region. In Utah, those varieties made up a substantial portion of the 6 million bushels of winter wheat, 9 million bushels of barley and over 1 million bushels of spring wheat harvested during 1990.

Plant breeders don't simply *look* to find the right plant, they *extricate* information via a routine whose repetition and apparent simplicity belie its precision—planting, sorting, bagging, weighing, measuring and remeasuring. And statistics—lots of statistics.

Plant breeding is less a gentle search for perfection than mercilessly scouring imperfection. In an average year, USU breeders start with about 500,000 individual barley and winter wheat plants. Fewer than 10,000 make it to the next stage of testing. And fewer than 100 make it to detailed field tests, the final step before a single line may be deemed worthy of release as a new variety.

The two plant breeders have seen enough shades of natural diversity to drive most people bonkers. It seems simple—cross two promising varieties or lines and sift through their progeny to find the one that nature has endowed with the right combination of genes. Such a plant probably exists. The problem is finding it.

A short attention span is a real liability in the search. The progeny of promising crosses are

coddled for five or six generations so genes can segregate, giving ample opportunity for each to show its true colors. Most of the progeny are flawed in some manner. Some topple over when heads are filled with grain. Others succumb to disease, produce shriveled seeds or aberrant leaves, or manifest one of dozens of imperfections.

The best advance to field tests at USU and around the state. After 9 years or so, only three or four lines are good enough to be tested in USDA regional nurseries located throughout the western U.S.

After regional tests, seed is planted one more time to check purity. Only then is a line released, more than a decade after pollen first met pistil.

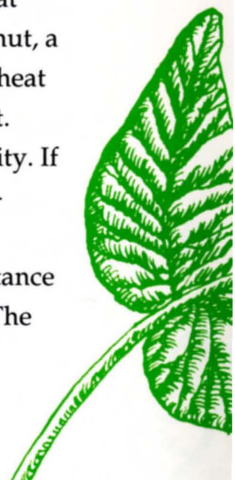
While at USU, Dewey developed seven varieties of winter wheat. Albrechtsen, who has taken over Dewey's chores, has released four varieties of barely and three varieties of spring wheat.

For obvious reasons, the release of a variety is seldom accompanied by the hoopla associated with sudden and serendipitous discovery. And there wasn't any hooting and hollering last year when they released three new varieties—two varieties of barley (Rollo and Walker) and a variety of dryland hard red winter wheat (Promontory).

Breeding resistant plants is the cheapest, safest and most reliable way to control plant diseases. For three-quarters of a century, USU's winter wheat breeders have successfully outwitted dwarf smut, a fungal disease that nearly wiped out winter wheat production in the state. It is still a severe threat.

"Resistance to dwarf smut is our top priority. If varieties weren't resistant, we'd be out of business," Albrechtsen says.

"A lot of growers say that a variety's resistance has 'run out' and that it's no longer resistant. The





variety is still the same genetically, it's just that the disease complex has changed. The organism has developed races that are virulent to these varieties," Albrechtsen says.

Unless breeders bring in new sources of resistance, however, dwarf smut threatens to gain the upper hand. USU plant breeders are now evaluating resistance in more than 2,000 varieties and breeding lines from around the world. The most promising of these will be crossed with the most resistant locally adapted varieties.

They are also trying to import different resistance from barley, a distant relative of wheat, via wide hybridization.

After wheat (the female parent) is hand emasculated, it must be treated with growth regulators and hormones to successfully cross fertilize it with barley. Any fragile embryos that develop must be "rescued" and grown on special media. The pampered plants from these embryos are sterile until treated with chemicals so chromosomes can pair.

So far, chemical treatment for chromosome pairing has not been successful. Another tactic to produce a fertile hybrid is to backcross the hybrid to wheat. "During the process, we hope to end up with part of the genome from barley that confers new dwarf smut resistance to wheat," Albrechtsen says.

They are also culturing the young inflorescence (head) of barley-wheat hybrids on a special medium, essentially cloning these hybrids, thereby reducing the risk of losing the only plant resulting from a barley-wheat union.

It won't be easy to coax the recalcitrant genes for smut resistance from barley into wheat. "It's about as difficult as

## 3 of the Best

Rollo and Walker are two 6-row irrigated spring barleys that were released last year. Only registered seed was produced in 1990, but there should be limited amounts of seed available this year. It will be about 5 years before the popularity of these varieties can be assessed.

Albrechtsen says each new variety of barley fills a slightly different market niche. Growers should consider Rollo if they are looking for top yield and reasonably good resistance to lodging. Those looking for higher protein and test weight and excellent lodging resistance should consider Walker.

Both new varieties are similar in appearance to Steptoe, a popular variety developed at Washington State University. Walker has rough awns and Rollo has smooth awns.

Promontory, a dryland hard red winter wheat released last year, came from a cross between Manning and a Russian variety. During tests, it outyielded Manning by about a bushel per acre. It has a heavier test weight (about 1.5 pounds more) than Manning. Promontory derived its excellent resistance to dwarf smut from the same source as Manning. It is also similar to Manning in height, straw strength and heading date.

A limited amount of Promontory seed should be available next year.

KG

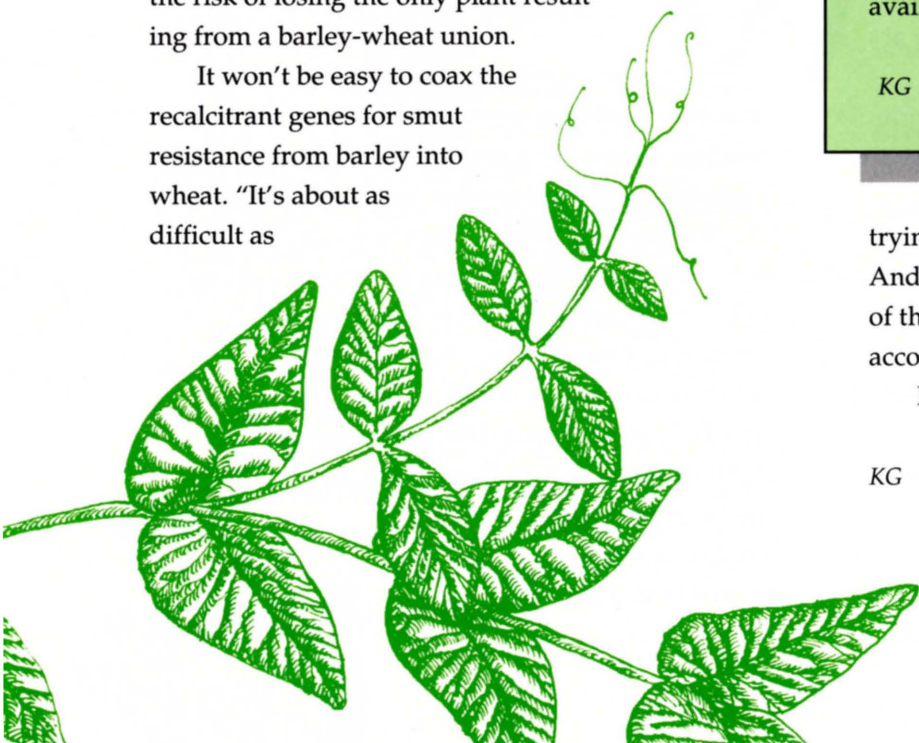
Rulon Albrechtsen 750-2243

trying to cross a cat and a dog," Albrechtsen says. And it won't be easy sifting through and getting rid of the hundreds of other undesirable genes that accompany those for disease resistance.

It will take time. But Albrechtsen is used to that.

KG

Rulon Albrechtsen 750-2243







# Additional NITROGEN May Boost Alfalfa Yields

**A**lfalfa may benefit from a little nitrogen fertilizer immediately after harvest.

Farmers don't usually apply nitrogen to alfalfa, whose roots can fix nitrogen from air. However, growers in California reported that yields increased significantly when they added small amounts of nitrogen (10 to 15 pounds per acre) immediately after alfalfa was cut. The lack of foliage after cutting causes a deficiency in photosynthates that alfalfa plants need to fix nitrogen.

When USU soil scientist Philip Rasmussen added 20 pounds of ammonium sulfate (21-0-0) or ammonium nitrate sulfate (30-0-0) after each cutting, yields increased by more than a ton per acre during 1989 and 1990. When alfalfa was valued at \$100 per ton, the nitrogen increased profits by \$70 to \$110.

The responses to three other types of nitrogen fertilizers that he studied (liquid calcium ammonium nitrate and ammonium nitrate) were not as consistent nor as profitable. Rasmussen attributes part of the larger increase in yield with ammonium-sulfate compounds to a possible sulfur deficiency at the test plots.

Another technique—applying phosphorus with no-till drills to established stands of alfalfa—doesn't appear to be as promising.

Most of alfalfa's roots are close to the surface, so farmers have usually top-dressed phosphorus where roots easily take up the nutrient. However, several farmers reported that yields on established stands increased when they used no-till drills to deep-band phosphorus.

In most no-till systems, the deep placement of dry fertilizers facilitates the uptake of nutrients by developing roots. On dryland, deep banding also places fertilizer in wetter areas of the soil, also aiding uptake. However, Rasmussen reports mixed

results with the technique at two sites, both of which were deficient in phosphorus: yields increased at one site (the field of a cooperating farmer at Vernal) but not at another (the Greenville experimental farm). "The jury's still out on this technique," Rasmussen says.

Deep-banding phosphorus would probably double the costs of application and is of no value unless soils are deficient in this nutrient. An alternative to deep-banding is to incorporate phosphorus in the seedbed. Enough can be added at seeding to last the normal life of the stand (3-4 years)..

KG

Phil Rasmussen 750-2257

## Tests Help Duplicate the FRIENDLY ENVIRONMENT OF A SEED

**W**hether snug in a seed or nurtured in a test tube, plant embryos need a special environment to develop. Tests developed by USU researchers make it possible to determine when conditions are right.

The new tests, which measure levels of plant hormones in tiny amounts of plant tissue, indicate when conditions in test tubes mimic the environment in a seed (where plant embryos normally develop). The more closely the *in vitro* environment resembles the hormonal and nutritional environment in a seed, the more likely cultured embryogenic cells will develop into normal embryos.



Embryogenic cells are often cultured for clonal propagation of plants and for use in genetic engineering. By improving the culture environment, the tests will facilitate the ability to regenerate genetically engineered plant cells.

"We have found that hormone levels in embryonic wheat tissue are extremely sensitive to the physical environment," says plant geneticist John Carman. One difference involves oxygen. Atmospheric levels of oxygen normally used in tissue

culture are much higher than in seeds. Those higher oxygen levels greatly reduce the amounts of several plant hormones necessary for normal development.

Graduate student Richard Hess developed the enzyme-linked immunosorbent assays that can determine levels of eight plant hormones in just a few milligrams of plant tissue.

KG

John Carman 750-2238

## Getting Closer to HYBRID WHEAT

**R**esearchers are developing a self-cloning wheat, which will overcome a major impediment to the development of hybrid wheat.

The self-cloning trait was acquired by crossing wheat with *Elymus rectisetus*, a wheatgrass from Australia. The Australian wheatgrass, which reproduces asexually, produces seeds that are genetically identical to the mother plant. For years, researchers have tried to transfer this trait, called apomixis, to wheat in order to produce true-breeding hybrid wheat.

Hybrid wheat promises to substantially increase yields, much as the development of hybrids increased corn yields almost 50 years ago. Most wheat cultivars are heavily inbred.

Currently, hybrid wheat can be produced only by laborious and expensive cross-pollination procedures. Desirable traits segregate during meiosis, which means that seeds from hybrid wheat plants inherit different traits than those of the hybrid parent plant. The transfer of apomixis to wheat would prevent this genetic segregation and make it much more feasible to produce agricultural quantities of hybrid seed.

The wheat-*E. rectisetus* hybrid was made by graduate student Zhi-Wu Liu under the direction of Richard Wang, research geneticist with the U.S.D.A. Forage and Range Research Laboratory, and John Carman, USU plant geneticist.

The resulting intergeneric hybrids (four plants involving two wheat varieties) have all the chromosomes of the wheatgrass (42 chromosomes) and one-half the chromosomes of wheat (21 chromosomes). The hybrid must have a full complement of both sets of chromosomes before it will be fertile. This can be achieved by additional crosses and by chromosome manipulations.

Carman will determine if the hybrid is apomictic. If it is, Wang and Liu could repeatedly backcross the hybrid with wheat, thus gradually eliminating all *E. rectisetus* genes except those that control apomixis. This could require several years.

Wang also plans to determine the mode of inheritance of apomixis, and may use genetic engineering techniques to transfer the apomictic gene to wheat.

The wheatgrass used in the cross was one of more than 100 accessions of apomictic wheatgrasses that Carman collected in Australia.

KG

John Carman 750-2238

Richard Wang 750-3222





# Weed Threatens NATIONAL FOREST

**D**yers woad doesn't respect boundaries, wildflowers or wilderness.

The weed, traditionally considered a threat to agricultural land and rangeland, could infest almost 99 percent of the land in the Logan District of the Cache National Forest. Many of the areas most highly susceptible to infestation are in the Mount Naomi wilderness area, according to USU researchers who used satellite images to predict the spread of the weed.

Some people oppose the use of herbicides in national forests and wilderness areas, claiming that dyers woad poses only a limited threat to these areas. That doesn't appear to be the case, says Steve Dewey, USU weed scientist who conducted the study with geographer Kevin Price.

The researchers compared currently infested sites in the Cache National Forest near Logan with satellite images of the same area. Spectral components were used to divide the satellite images into 60 types of cover. Researchers found that 55 of these types of cover, representing 98.8 percent of the forest, were similar to sites now infested by the weed. Conditions in 10 types of cover representing 17 percent of the forest were similar to those in areas already seriously infested by the weed.

"We were extremely conservative in our approach. Dyers woad is a lot more versatile than the results of our study indicate," Dewey says.

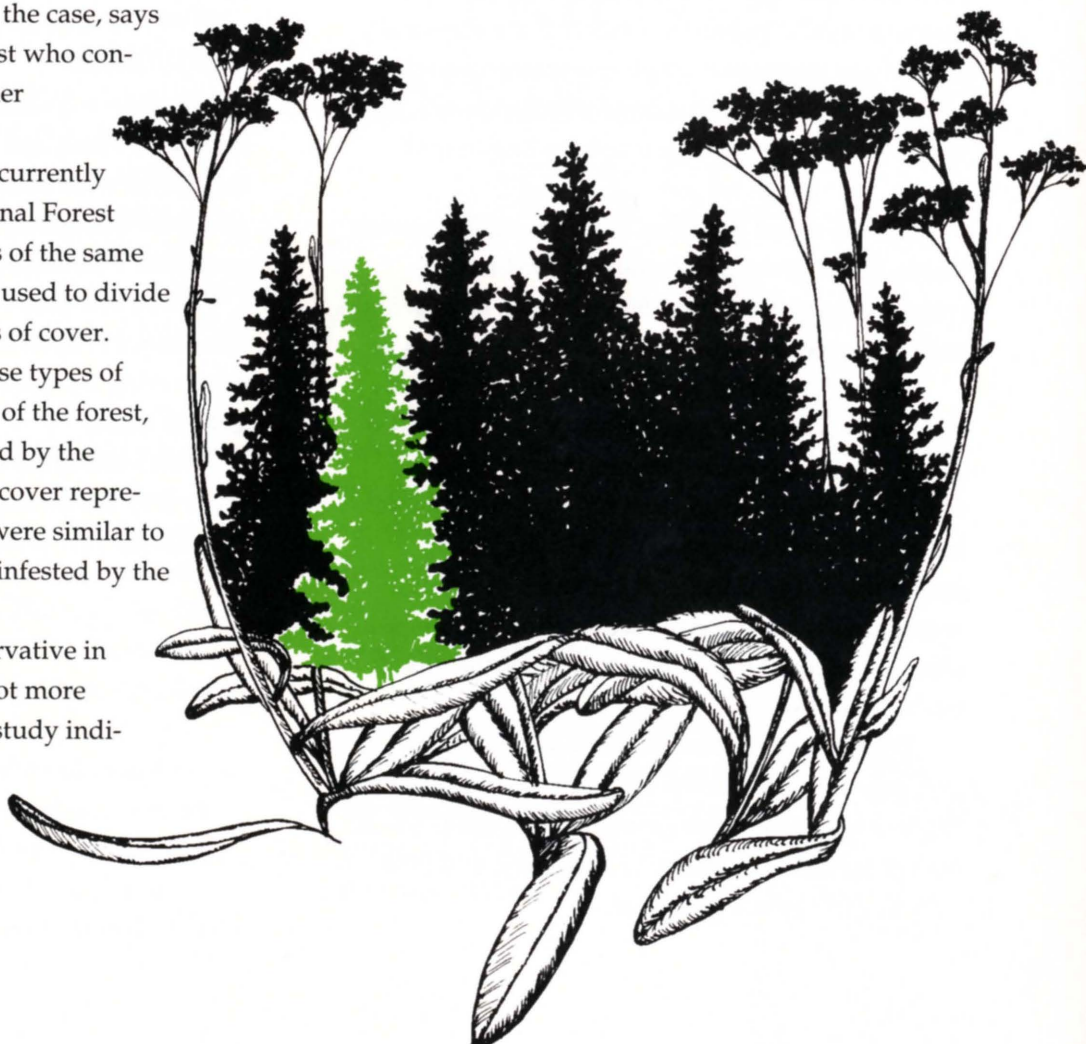
Dewey says dyers woad is relatively easy to control with herbicides. However, delaying

control until it infested large areas would mean the loss of many desirable plants, including those used by deer as winter range, and would make it much more difficult to control without damaging native vegetation. "We definitely should try to eradicate small infestations, and perhaps spray the perimeters of existing large infestations to keep the weed from spreading," he says.

There are now only scattered infestations in the Mount Naomi wilderness area. However, conditions in the area seem to favor a rapid spread of the weed.

KG

Steve Dewey 750-2256





# Research in Brief

Spring 1991

## Topography Shields UINTA BASIN from Many Storms

Why is the Uinta Basin usually drier than surrounding areas? A report by the Office of the State Climatologist at USU suggests that topography is the major culprit.

Precipitation in the Uinta Basin is governed by some basic and immutable meteorological phenomena. The region is surrounded by mountains or high plateaus. When storms slam into these high areas, air rises, moisture condenses, clouds form and precipitation falls. However, once storms pass over these high regions, air slides down and warms slightly, just enough to hold more moisture. This warming causes clouds to dissipate and precipitation to diminish before storms reach the Uinta Basin.

After the air masses reach the Uinta Basin, little precipitation is wrested from these air masses until they hit the Rocky Mountains.

The climatologists also found that the direction storms travel also affects precipitation in the Basin. Large storms tend to become less intense as they travel from the north and northwest toward the southeast, which decreases the likelihood of precipitation in the region. How-

ever, storms approaching from the southwest and south tend to intensify. As they intensify, the air mass tends to rise, which usually overcomes the mountain effect and results in more precipitation in the Uinta Basin.

Of the moisture-laden storms approaching from the west and northwest, few produce precipitation in the Uinta Basin, the climatologists say. Instead, the Uinta Basin gets most of its precipitation from winter and spring storms that approach from the southwest and southeast.

The climatologists examined precipitation records from various divisions in the state. Precipitation in the Basin was more closely associated with precipitation in southern Utah, which confirmed the importance of moisture-bearing storms that approach the Uinta Basin from the south.

An analysis of precipitation records also indicates that the drought now gripping the Basin is similar to previous dry spells that affected the region.

The Uinta Basin receives slightly less than 8 inches of precipitation annually, slightly less than the precipitation in the Southeast Division of the state. Average annual precipitation in the division west of the Basin (the Northern Mountains) is almost 19 inches.

The study was funded by the state's Division of Water Resources.

KG

State Climatology Office 750-2190



## HELPING ROOTS GET MORE IRON

A substance excreted by the roots may explain why some plants resist iron deficiency (chlorosis), a costly problem that plagues farmers and home gardeners in many regions of the world.

Many cultivars don't take up iron efficiently, no matter how much iron is available, says USU biologist George Welkie, who is determining why the roots of iron-deficient plants excrete riboflavin, a B vitamin.

Chlorotic plants change markedly in four or five days, Welkie says. Roots become thicker and are covered with more hairs. The epidermis of the roots produce a different kind of cell. Plants decrease the pH around their roots, and reduce and take up iron almost ten times faster than usual.

These changes are accompanied by the production of riboflavin.

Once plants take up iron, root growth reverts to normal. "You can see traces on roots of this cycle where the roots are swollen and then thin again," Welkie says.

Above ground, iron deficiency is characterized by yellowing leaves. Leaves turn green once roots adapt and take up more iron.

Determining how riboflavin (or another related compound) helps stressed plants reduce and use iron will help researchers identify the gene responsible for the trait. The gene from a highly chlorosis-resistant plant could then be isolated and transferred to a less resistant plant.

For example, the gene responsible for resistance in tobacco or certain peppers might be transferred to soybeans, which are especially susceptible.

Beans and the plants, strawberries, raspberries, stone fruits and plants related to the rose family are among the plants prone to iron chlorosis.

Welkie says plants are especially sensitive to chlorosis when the soil is very wet and cold.

"Flood irrigation, and particularly over-irrigation reduces the oxygen in the soil and chills the soil," he says. Determining the temperatures that favor a plant's ability to overcome iron-stress may help growers irrigate so they avoid chilling the roots.

Welkie says iron amendments are costly and not feasible to use on large fields, so researchers are looking for new solutions.

LH

George Welkie 750-1581

## GETTING MORE IRON

### FROM MEALS

Why is the iron in meat more readily absorbed than in many other foods? An answer to that question may eventually make it possible to correct iron deficiencies without relying on iron supplements.

USU nutritional scientists Charles Carpenter and Arthur Mahoney are studying which dietary components enhance and which inhibit the body's ability to absorb iron. While iron supplements can correct iron deficiencies, the best—



those with the highest proportion of absorbable iron—are fairly expensive. Many cause gastric discomfort. And besides, most diets contain enough iron, which, for some reason, simply isn't absorbed.

Meat may hold the clues as to why. Meat, particularly the heme iron in the red pigment of meat, is more readily absorbed than iron from most foods. Heme iron also improves the absorption of iron from other foods.

It's estimated that 3 percent to almost 6 percent of Americans suffer from iron deficiencies. Preschool children, adolescents, women of reproductive age, and the elderly are more likely to be afflicted.

Understanding the uptake of iron may also explain how other nutrients are absorbed, Carpenter says.

There are several theories as to why meat iron is more readily absorbed.

Iron must be in a soluble form to be absorbed by the intestines. The researchers speculate that meat may contain a water-soluble component that combines with iron, thus keeping iron in solution, even in the intestine, which has a neutral pH. In many cases, iron solubilized in the acid environment of the stomach precipitates when it reaches the intestine, making it impossible for the body to absorb it.

Another theory is based on the fact that meat—especially red meat—increases the production of stomach or gastric acid. This acid increases the solubility of iron in food, thereby helping iron link with other elements or compounds that will keep it in solution.

Eating more iron-rich foods won't necessarily increase iron levels in the body because the percentage of iron absorbed decreases as iron intake increases, Carpenter says.

There are already several things people can do to increase iron intake. Ascorbic acid (vitamin

C) increases iron absorption. The fiber-rich portion of some grains contains phytic acid, which inhibits iron absorption.

For those reasons, having orange, grapefruit or tomato juice, which are high in vitamin C, will increase the amount of iron absorbed from breakfast cereal or other foods. Potatoes and cabbage are also fairly good sources of vitamin C that can enhance iron absorption.

LH

Charles Carpenter 750-3665

Arthur Mahoney 750-2125

## NEW FACULTY

**Kitt Farrell-Poe** has joined the Agricultural Education Department. Her research will address water quality, environmental safety and the treatment of heavy metals in waste. She earned an MS degree (agricultural engineering) and PhD degree (civil and environmental engineering) from Purdue University. She was the first female to earn a BS degree from the University of Nebraska in agricultural engineering.

**David J. Hole** has joined the Plants, Soils and Biometeorology Department as plant breeder/geneticist for small grains. He earned his MS degree in plant breeding and cytogenetics from Iowa State University and his PhD degree from Texas A & M University in genetics.

**Lynnette Harris** is science writer with USU Information Services and the Utah Agricultural Experiment Station. She earned a BS degree in journalism from USU and was education writer with The Herald Journal in Logan.

**Jennifer MacAdam** is forage scientist with the Plants, Soils and Biometeorology Department. She earned MS and PhD degrees in agronomy (the interdisciplinary plant group) from the University of Missouri-Columbia. Her post-doctoral research at that university involved ruminant nutrition and plant stress physiology.



## Farmers And Ag Businesses Contribute Money to Purchase Land for Expansion of BLUE CREEK DRYLAND FARM

**F**or the second time in 26 years, dryland wheat farmers and related businesses in northern Utah and southern Idaho have dug into their own pockets to support agricultural research.

The latest show of support resulted in \$25,000 to purchase 50 acres for the Blue Creek Dryland Farm, a research facility of the Utah Agricultural Experiment Station. The fund-raising campaign duplicated a similar effort in 1964 when farmers purchased land for the farm.

"If it weren't for the experimental farm, I can honestly say that I would not have stayed in business," said Deloris Stokes, Tremonton, who headed the fund-raising campaign. "The release of smut-resistant wheat increased yields from 10 to 50 bushels. We finally had a bin of wheat to sell. I'm 100 percent sold on what's been done and what's going to be accomplished. We needed more land for research."

Many donors had contributed money 26 years before—and said they were happy to help again, Stokes added.

The additional land, which more than doubles the size of the research farm, represents a vote of confidence in dryland farming in the region and in the value of agricultural research, said H. Paul Rasmussen, director of the Utah Agricultural Experiment Station.

Farmers purchased the original 40-acre site to support research to combat smut, a fungal disease that threatened to wipe out wheat production in the area. Disease-resistant varieties

developed at the research farm subsequently solved the problem. Since then, dryland wheat production has flourished as farmers applied the results of other research concerning tillage practices, soil fertility, and seed improvement.

Stokes was assisted by Darvel Garn, Fielding, and Ross Rudd, Garland. More than 100 farmers, businesses and farm organizations contributed money to purchase the land.

Garn said research at the Blue Creek Dryland Farm is responsible for "wheat yields that were unheard of 40 years ago. These yields have kept us in the farming business.

"Smut was so bad that wheat production dropped by 50 or 60 percent. Dust from fungus spores was so bad that during harvest combines were black and fields looked like they were on fire," he added. "And snowmold control has let us raise fall wheat, which usually produces double the yield of spring wheat."

The Utah-Idaho Grain Exchange was a major contributor. Lew Spears, president of the Exchange, wrote that without the research, "our jobs would have been, at times, insurmountable."

Ray Cartee, director of research farms for the Experiment Station, said the lack of space made it impossible to replant stands and reduced the number of replications required to accurately compare differences between plots. Ten acres of the additional land will be used to compare different types of tillage, including chem fallow



(controlling weeds on fallow fields with herbicides), and no-till and conventional tillage systems. "It now appears that the optimum tillage program is somewhere between no-till and conventional tillage," Cartee said.

Fifteen acres will be used to expand studies of snow removal on winter wheat in which darkening agents are applied to accelerate snowmelt, thus reducing the incidence of snowmold, another fungal disease of wheat. Researchers are also studying the effectiveness and feasibility of applying herbicides and fertilizers with the darkening agents, which Cartee said could increase yields and reduce production costs.

About 4 acres will be used to test new varieties of grasses and dryland alfalfa, including a comparison of fall versus spring planting of alfalfa. Six acres will be used to study weed control on set-aside acreage. Acreage is also available to accommodate new research, Cartee says.

Rasmussen said research at the Blue Creek Dryland Farm will ensure that dryland farming continues to be a viable component of the state's economy. It is another example of how the Utah Agricultural Experiment Station serves the residents of the state.

KG

## DONORS

Adams Land & Cattle Company Brigham City	Bear River Fertilizer Randy Grove Garland	Connor Cattle Company c/o Pratt Holmgren Penrose	Fuhriman Farm Logan
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# Research in Brief

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## IRRIGATION SYSTEM AUDITS OFFER SUBSTANTIAL SAVINGS

**A**n audit. Unsettling news when it's your income taxes. Good news when it's your irrigation system.

Irrigation system audits helped many farmers and managers use water more efficiently and more profitably, says USU irrigation engineer Robert Hill.

An audit, which examines both the efficiency of the irrigation system and uniformity of application, can pinpoint deficiencies in hardware, maintenance and management. One common problem is low pumping efficiency, says irrigation engineer Niel Allen, who visits the sites and conducts the fieldwork. Other recommendations often concern the amount and timing of irrigation.

Some recommendations can be costly to implement, but are warranted by the reduction in pumping costs, savings in water and other expenses, and increased production.

For example, a farmer in Nephi cut irrigation costs by 30 percent when he changed his wheel lines and replaced two pumps. Another farmer increased the efficiency of his surface irrigation system from 35 to 80 percent by using the stream in one border at a time instead of spreading it over several borders.

Recommendations increased the uniformity of application in a sprinkler system in a city park after it was discovered that the amounts applied ranged from one-tenth inch to eight-tenths inch.

Hill says concern over the impact of irrigation on water quality is likely to spur interest in the efficient and uniform application of water. Turf grass irrigation systems may warrant further study because growers tend to over-irrigate and make extensive use of chemicals to protect the aesthetic quality of grass.

Last year's audits involved tests of 89 irrigation pumping plants and the evaluation of 29 irrigation systems at farms, parks and golf courses in nine counties. The audits were funded by the Utah Agricultural Experiment Station and the Utah Department of Agriculture, with support from the Utah Energy Office and the U.S. Environmental Protection Agency.

Audits can be arranged by contacting either county USU Extension offices or the researchers. There is a reservation fee for the service.

LH

Robert Hill 750-2791

Niel Allen 750-1265



## RECENT GRANTS AND CONTRACTS

**Lawrence Hipps**, Plants, Soils and Biometeorology Department, has received a grant from the Agricultural Research Service (USDA) for surface atmospheric interaction and basin scale evapotranspiration studies in semiarid regions.

**Roger Coulombe**, Animal, Dairy and Veterinary Sciences Department, has been contracted by the U.S. Department of Defense/Army to study the preclinical pharmacology of antiviral agents. He is also studying the primary toxicology of aflatoxin B<sub>1</sub> for the National Institutes of Health.

The U.S. Department of Defense/Army is funding chemotherapy studies using compounds tested against viruses of military importance by **Robert Sidwell**, Animal, Dairy and Veterinary Sciences Department. Various drug companies also support his antiviral evaluation of newly synthesized chemicals.

**Von Mendenhall**, Nutrition and Food Sciences Department, is studying the ultra-high temperature processing of meat surfaces in a study funded by J. R. Simplot, Inc.

**Steven Aust**, Biotechnology Center, has received a Science and Engineering Grant from the Du Pont Company to enhance university teaching and research in science.

The Western Dairy Foods Research Center has funded research to characterize milk proteolysis by lactococcal starter cultures using amino acid analysis by **Rodney Brown**, Nutrition and Food Sciences Department.

Research by **Gail Bingham**, Plant, Soils and Biometeorology Department, on water yields in semiarid environments under projected climate change is supported by the Bureau of Reclamation, U.S. Department of the Interior.

**Dale Barnard**, Animal, Dairy and Veterinary Sciences Department, is studying the mode of action of natural or synthetic antiviral agents. The research is funded by Shaman Pharmaceutical.

The Division of Water Resources, Department of Natural Resources, State of Utah, is funding an analysis of crop yields vs. time and water supply by **Herb Fullerton**, Economics Department.

**Daren Cornforth**, Nutrition and Food Sciences Department, is studying the factors causing the reappearance of pink color in cooked, vacuum packaged pork products. The study is supported by the Pork Industry Group of the National Live Stock and Meat Board.

**Don Snyder**, Economics Department, is determining the market for cull cows and the feasibility of backgrounding and feeding cattle in the state. Both studies are funded by the Utah Department of Agriculture.

**Phil Rasmussen**, Plant, Soils and Biometeorology Department, is evaluating the miranda protein pea, rye and protein pea rotations for irrigated agriculture, and a computer enhanced low-level remote sensing system (USU-CELLVIS) for the Utah Department of Agriculture. The Tennessee Valley Authority supports fertilizer tests and demonstrations on permanent water quality plots.

**Deevon Bailey**, Economics Department, is studying the feasibility of modifying local processing facilities to process and freeze Utah-grown onions, carrots and potatoes. The study is supported by the Utah Department of Agriculture.

The National Dairy Council has funded a study of the contribution of dairy and other food products to total dietary fat and saturated fatty acid intakes of children in the United States by **Carol Windham**, Nutrition and Food Sciences Department. The Ezra Taft Benson Agriculture and Food Institute at Brigham Young Institute is supporting her evaluation of the vitamin A status of children of resident and migrant Spanish-American laborers in Utah.

The Utah Department of Agriculture continues to support energy conservation in agriculture through irrigation audits by **Robert Hill**, Agricultural and Irrigation Engineering Department.





# GOOD MANAGEMENT OF ALFALFA

More Important  
Than the Number of Leaves

**I**f alfalfa leaves are the most nutrient-laden and digestible portion of the plant, a variety with more leaves should be more nutritious and more valuable.

That at least is the theory underlying the development of multileaf varieties of alfalfa available from several seed companies. Good theory, but it doesn't quite pan out.

There hasn't been much difference in the quality and yield of conventional (trifoliate) and multifoliate alfalfa varieties tested in Utah, says USU agronomist Ralph Whitesides. Yield and quality of one multifoliate variety that was tested were about average. The other did better than average, but still no better than the best trifoliate variety.


Management appears to be a far more important determinant of quality than the number of leaves, Whitesides says. Cutting at the recommended time, reducing leaf loss during harvest, and proper fertilization, irrigation and weed control will probably boost quality much more than just selecting a multifoliate variety.

Any potential gains from a multifoliate variety may vanish if plants don't produce multiple leaves throughout a field, or under all conditions, Whitesides says. The size and retention of leaves are also factors that should be considered, as well as attributes such as winterhardiness and disease resistance.

The bottom line: "At this time, it's difficult to justify paying a premium of 30 to 50 cents a pound for seed of multifoliate varieties," Whitesides says. "All of the varieties tested performed well if they were managed properly." However, Whitesides says multifoliate varieties may hold the key to future improvements in alfalfa quality.

Test plots were located at experimental farms in Logan and Kaysville.





USU soil scientist Phil Rasmussen, research associate Robert Newhall, and systems analyst Jim Belliston head skyward with their remote-sensing equipment.

# A HIGH-ALTITUDE LOOK

At Down-to-Earth Phenomena





ver hundreds of thousands of years, forces as unobtrusive as decomposing plants and as violent as volcanoes gradually deposited a thin mantle of soil over the state.

In Utah, we have tramped, scraped, poked, dug and plowed this fragile crust for just a century. Unfortunately, we often treat soil like dirt. And while Utah contains some awesome examples of the erosive force of wind and water (just take a gander at any of the national parks in southern Utah), erosion also gouges cropland, whisking away the priceless residue of millennia in a few seconds.

But we're seeing soil (and erosion) in a new light these days, thanks to an innovative remote-imaging system developed at USU. The system promises to help farmers cut soil erosion, improve crop production and take better inventories of our natural resources. Moreover, it's much cheaper than most of the alternatives.

Utah is one of the drier states, but runoff from occasional heavy rains can scour away topsoil. Because much of the state is federally owned and the proportion of cropland is relatively small, average soil-erosion rates in Utah are deceptively low, says USU soil scientist Phil Rasmussen. But overall rates simply mask the severity of erosion on some cropland. "It takes 10 to 100 times as long to create soil in the cold, dry climate such as Utah, so a loss of 1 ton per acre here may be equivalent to a much greater soil loss in Iowa," Rasmussen says.

For years, researchers have used aerial views of the landscape to monitor erosion on cropland and inventory other natural resources. Unfortunately, it's often difficult to extricate the information contained in these airborne views. Analysis usually requires expensive computers capable of digesting huge chunks of information and people who are unafraid to delve into the deepest recesses of computer programs. Many aerial views of the landscape, particularly glimpses provided by satellites, are obscured by clouds, too expensive or not available when needed.

Not any more. The system developed by Rasmussen and Jim Belliston, systems analyst, uses low-tech equipment to provide high-tech information. It's known as the Computer-Enhanced, Low-Level Video Imaging System (CELLVIS). One of

CELLVIS's most powerful attributes is its ability to mesh video images with maps and other types of information. This provides a new perspective on problems—and on potential solutions.

The USU researchers videotape the landscape from an airplane at an altitude of 2,000 - 2,500 feet using inexpensive (about \$800) off-the-shelf video cameras that have been modified to capture near infrared (NIR) light. (The modification involves removing a filter over the light-sensing computer chip.) "It's a poor man's system," Rasmussen says. The ability to monitor the quality of the image while airborne can eliminate many costly return trips.

Rasmussen and Belliston, who is a pilot, fabricated the total system for \$10,000-\$15,000, a fraction of the cost of most commercial systems. The video images are then fed into a computer where research associate Tom Furst integrates them with other digitized information, such as soils maps of the state.

The ability to overlay or peel away certain features often unmask new relationships. For example, Rasmussen says soil type seems to have the most effect on the NIR "signature." Combining the NIR image with the soil type should identify areas prone to soil erosion and determine the status of crops.

Rasmussen says the system should be extremely useful in farm management. Near infrared wavelengths are sensitive to changes in plant leaves under stress, which can be induced by water, diseases, nutrient deficiencies or insects. One farmer already is modifying the system to determine the status of his potato fields.

The Soil Conservation Service is trying the USU system in its National Resource Inventories, a survey mandated by Congress every 5 years in which several hundred areas in the state are examined to determine changes in land use and other characteristics. Low-level remote sensing could save millions of dollars by eliminating the need to visit every site. (Randomly selected sites would be visited to check the interpretation of the videotaped images.)

Images from a more expensive camera captures energy in the true (thermal) infrared range, a wavelength related to the temperature of an object.



"The temperature of the leaf changes dramatically at the first sign of stress. The system, which is a modification of that which the military uses to detect enemy troops at night, can be used in irrigation scheduling," Rasmussen says.

"We're looking for even cheaper ways of conducting remote sensing," Rasmussen says.

They will probably succeed. USU soil physicist John Hanks has already developed a bargain-basement remote sensing system: He suspends a small still video camera or a 35 mm camera from a

balloon to take "snapshots" of research plots via remote control. Rasmussen also plans to mount a TV camera in a small radio-controlled model helicopter. The bird's eye view provided by the television camera will let ground-based researchers control the helicopter and aim the video camera.

KG

Jim Belliston 750-2507

John Hanks 750-2175

Phil Rasmussen 750-2257

## USU System Will Mean More Uses for BETTER SOIL SURVEYS

**F**or almost a century, soil scientists in the United States have diligently scuffed about the country describing and mapping soil, using a vernacular (e.g., Alfisols, Inceptisols, Mollisols, Spodosols) that might describe interplanetary visitors. (The idiom of soil taxonomy reflects its Greek and Latin origins.)

Soil scientists have identified more than 15,000 series of soils...and they're not done yet. CELLVIS, the remote imaging system developed at USU, should make soil mapping far easier. This system will also make soil surveys far more useful, says Tom Furst, soil scientist and research associate, who merges pictures from CELLVIS with maps and sundry other images.

Detailed soil maps are available for about 70 percent of the state. USU researchers don't conduct soil surveys (that's the responsibility of several government agencies) but they do help and try to make surveys as useful as possible.

Like road maps, soil surveys are indispensable guides to a variety of objectives. Large-scale soil maps indicate the prospects for agricultural production and guide economic development. More-

detailed soil maps are used by farmers, highway engineers, construction engineers, and many others. The detail of soil maps varies widely, from general maps of mountainous regions or rangelands to those that examine the characteristics of every square foot of ground, as might be required for a proposed waste-disposal site.

Aerial photographs are often used to identify soil map units according to vegetative cover. The ability of infrared reflectance to detect differences between different plant tissues and, as long as the soil isn't completely covered, between different soil types will make soil mapping easier and more accurate, says USU soil scientist Phil Rasmussen.

Images from the CELLVIS will also help determine the accuracy of some long-held theories about the relationship between soil and climate. Some soil scientists question whether the soil climate classifications, which are based on soil moisture and temperature, actually mirror conditions in Utah, particularly since the techniques originated in eastern states.



A knowledge of soil climate helps determine grazing capacity, land use, and reclamation potential. "More and more, land use management is driven by the attempt to find the best, most productive use, whether it be recreation, grazing or wilderness. The accuracy of climatic classification of soils has tremendous implications in Utah, where 70 percent of rangelands are publicly owned," Rasmussen says. The best use of rangelands, which Rasmussen describes as "vast solar collectors that produce vegetable energy," may hinge on the USU research.

Soil-climate classifications for many regions in Utah were based on unpublished or unconfirmed data. "Soil surveyors have a limited amount of time to conduct surveys, and can't collect long-term data on moisture and temperature," Furst says. Several years ago, 11 states in the west began a cooperative research project to clarify some of the inconsistencies in soil climate classification between states. That project spurred the installation of 22 automatic soil-climate weather stations around Utah.

Furst now has moisture and temperature data from 10 of these stations and from 10 of the Snetel stations that the Snow Survey Unit of the Soil Conservation Service uses to monitor snowpack. This information will let him evaluate the accuracy of the soil climate classification system, and to clear up some of the inconsistencies between Utah and neighboring states.

One persistent anomaly concerns soil climate classifications that often differ at state lines, even though soils and climate are similar on both sides of the imaginary line. For example, there are few xeric (dry summers, moist winters) moisture regimes in Colorado and Nevada, even though they abound in adjacent Utah.

Furst will classify the state into soil-climate regimes. Only a small area around St. George appears to be thermic (a mean annual soil temperature of 59°F characteristic of cotton-growing regions of the U.S.). Many valleys and lower slopes are probably mesic (47°F, characteristic of corn-growing regions). Some areas at higher elevations are probably cryic (32°F, characteristic of wheat-growing regions).

Furst also hopes to clarify differences in soil climate regimes between western and eastern Utah. The eastern part of the state receives more moisture as clouds dump moisture when they pass from west to east over the Wasatch Front and other north-south mountain ranges. The same phenomenon appears to be true in Nevada, which is riddled by several similarly oriented mountain ranges.

There are similar concerns over the system used to describe moisture regimes. Researchers debate whether, for example, a xeric moisture regime, which is characteristic of Mediterranean climates with moist, cool winters and warm, dry summers, adequately describes conditions in noncoastal areas. A udic regime is characteristic of humid areas where the soil never completely dries out.

"By default, we say that higher elevations in Utah have a udic moisture regime because we have assumed that there is not enough heating and evaporation to dry out the soil. However, my suspicion is that soils at the higher elevations may become dry, and perhaps be classified as aridic," Furst says.

Utah was the site of some of the earliest soil surveys conducted in the United States. Two soil scientists from the U.S. Department of Agriculture spent 4 months in the Salt Lake Valley in 1899, and another made a brief reconnaissance of the soils in Utah, Sanpete and Cache counties the same year.

To illustrate how irrigation had transformed the Salt Lake Valley, the soil scientists' included the following description of the Salt Lake Valley, written by an unnamed historian of the Mormon Church, in their account: "A desolation of centuries, where earth seemed heaven forsaken, where hermit nature—watching, waiting—wept and worshipped God amid eternal solitude."

CELLVIS is good, but it will never capture images like that.

KG

Tom Furst 750-2063  
Phil Rasmussen 750-2257





**F**or decades, farmers have "banked" phosphorus in the soil. USU researchers think they can help farmers withdraw this nutrient.

"Fertilizers have loaded soil with phosphorus, most of which is in a form that's unavailable to plants," says USU soil chemist Lynn Dudley. As little as 10 percent of the phosphorus applied annually is utilized by plants. The rest remains in the soil.

Some plants produce a strong acid (oxalic acid) that lets them extract this phosphorus. If Dudley's research confirms the role of oxalic acid in phosphorus utilization, crops could be inoculated with

bacteria or fungi that have been genetically engineered to produce more acid, thus tapping this huge reservoir of stored phosphorus.

The ability to produce oxalic acid apparently explains how some plants can colonize low-phosphorus soils. Dudley says many organic acids can free phosphorus by dissolving calcium phosphate and forming a complex with calcium, but none are as effective as oxalic acid, which precipitates calcium in solid form.

A Canadian researcher is trying to increase the availability of phosphorus by inoculating wheat with bacteria that produce acids which can dissolve calcium phosphate. The acids produced by these

## After Years of BANKING PHOSPHORUS,

It May Be Time  
for a  
Withdrawal





microbes have not been identified, however. Dudley says it would be much more effective to rely on microbes that produce oxalic acid whose phosphorus-releasing ability is superior.

Dudley, soil chemist Jerry Jurinak and research assistant Barbara Lilieholm are determining phosphorus availability in calcium-rich soils with a near-neutral pH, the predominant soil types in the West and in arid and semi-arid regions throughout the world. Reactions in the soil may not always proceed according to theory however. "There's some evidence that a surface coat may form and prevent dissolution of calcium phosphate by oxalic acid in calcium-rich soils," Dudley says.

USU researchers are also studying the role of oxalic acid on disturbed sites, such as mine spoils, where the phosphorus-rich topsoil has been mixed with the phosphorus-poor subsoil. Nitrogen usually

limits plant growth on rangeland soils. Phosphorus limits plant growth on disturbed sites, where annuals such as Russian thistle and halogetan, which seem to produce large amounts of oxalic acid, are usually the first plants to gain a foothold. Grasses gradually succeed these weeds, perhaps due to the residual benefits of oxalic acid.

The researchers are testing these relationships in a combination of greenhouse and field studies. The three-year study on the relationship between oxalic acid, phosphorus availability and plant succession is supported by the Utah Agricultural Experiment Station and the National Science Foundation and involves researchers Edith Allen and Michael Allen with San Diego State University.

KG

Lynn Dudley 750-2184  
Jerome Jurinak 750-2173

## PEAS Please Livestock and Farmers

Miranda yellow peas, a substitute for soybean meal in livestock rations, promises to become a major cash crop for Utah farmers.

About 100 farmers in the state now grow the high-protein pea, a legume which fixes about 40 to 60 pounds of nitrogen per acre. The peas also appear to be suited to double-cropping with oats or barley, says Phil Rasmussen, USU soil scientist who has studied the crop for three years.

Yields tend to range from 2,500 to 4,500 pounds per acre; yields that top 3,000 pounds are profitable.

The pea's popularity among growers and livestock producers in the state has increased quickly since the first trial planting in 1988, which was in conjunction with Moroni Seed & Feed Co. This firm now purchases Utah-grown peas to feed turkeys.

Rasmussen's studies show no appreciable difference between no-till and conventional tillage systems in pea yields, although he says many producers are having some trouble with weed control in the new crop.

Substituting the peas, which thrive in Utah's rather cold harsh climate, for soybean meal imported from other states bolsters local economic growth. Rasmussen also expects prices for the pea to improve as supplies increase and as livestock producers become aware of its merits.

Rasmussen's research is supported by a grant from the Utah Department of Agriculture.

KG

Phil Rasmussen 750-2257





# FARMING...

## With Friends

**E**very spring during the crush of fieldwork, Ray Cartee sheds most of his "other" occupations and acquires the full coloration of farmer.

Experiment Station research encompasses diverse topics and laboratory research, but it still involves plenty of seat-of-the-pants farming. And

Ray Cartee, director of research farms (center) and, from left to right, Jeff Slade, research assistant, Doyle Knudsen, farm foreman, Wallace Kohler, supervisor, Craig Thompson, farm foreman, and Orlin Lusk, farm foreman.







that's Cartee's bailiwick. As director of research farms, Cartee still relishes opportunities to muscle a tractor, commandeer a chopper or jockey a combine. These days, however, hands-on farming chores often play second fiddle to his duties as supervisor, researcher and teacher.

The most difficult part of his job? Cartee doesn't mind the work, but says he originally found it difficult to delegate authority and "not just go off and do it myself." He learned to do it himself while farming in southern Idaho for 13 years before he came to USU and earned a BS degree in soil physics (1971) and an MS degree in soils and irrigation (1972). He's been at USU ever since, first as farm manager, and now as farm director and assistant research professor.

Cartee is remarkably unruffled for someone who supervises five permanent employees and 10 part-time employees, manages more than 1,200 acres of cropland, and accommodates more than 50 project leaders who use Experiment Station land for field research. He credits skilled and competent employees, especially Wally Kohler, supervisor of research farms, for his ability to remain calm.

His position as director is not much different than the way he used to farm.

So he says.

That may be a shade short of the truth. He previously didn't farm with 12 tractors, six balers and enough additional equipment to outfit a small

farm implement dealership, all of which is required to plant, maintain and harvest crops on six agronomy research farms and five farms that produce feed for livestock. He's responsible for cultivation, planting, fertilizing, irrigation, spraying, cutting, baling, hauling, harvesting and storing crops, as well as keeping meticulous records and maintaining equipment.

A partial tally of the crops produced on Experiment Station farms during 1989: nearly 30,000 bales and 900 tons of hay, more than 1,600 tons of haylage, almost 1,500 tons of corn silage, 8,400 bushels of grain, and 100 tons of straw.

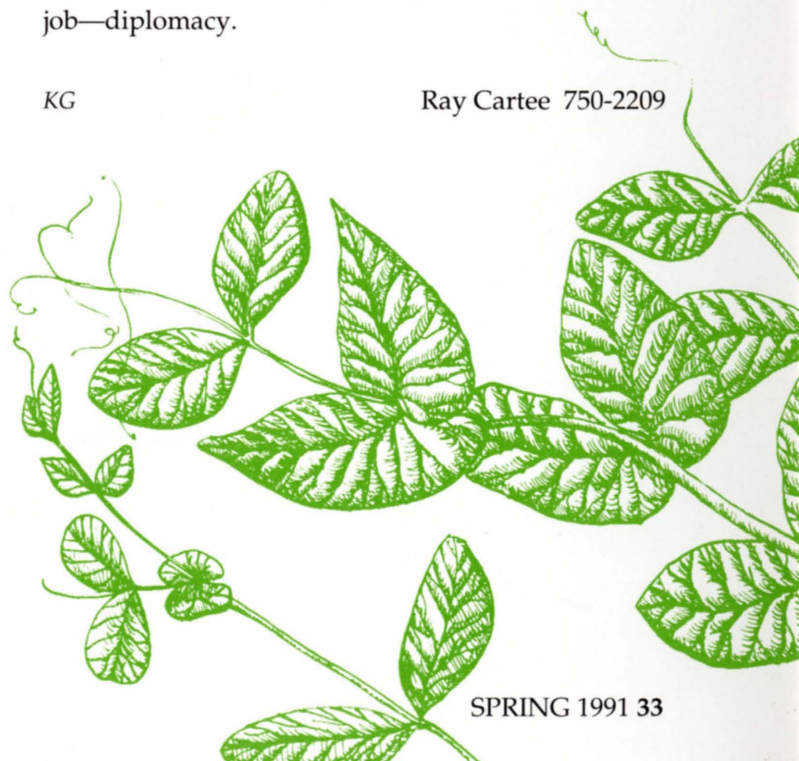
Total yields don't reflect the painstaking care often required to nurture research plots. These aren't just any crops. All represent years of work. Some will provide the answers to problems that plague agriculture, or the avenues to remarkable gains in productivity.

Plenty of people look over Cartee's shoulder. Farmers don't have to accommodate several dozen researchers and report to several administrators. These people tend to be rather finicky, and not in the least reluctant to express themselves.

Cartee says he finds them "easy to get along with." No doubt they are. And no doubt Cartee has had ample opportunity during the past two decades to hone one skill that is probably essential in his job—diplomacy.

KG

Ray Cartee 750-2209





**T**hese wheat farms are puny but prolific. There are more than four wheat heads per square inch, some of which are laden with more than 200 seeds per head. Yields are five times the world's record.

Small wonder. Bruce Bugbee and colleagues cheat. Flagrantly.

The wheat plants growing in the closet-sized cubicles are probably the most coddled vegetation on earth. Chloroplasts are drenched in light. Roots are bathed in nutrients. Controlled breezes with high levels of carbon dioxide waft over every leaf.

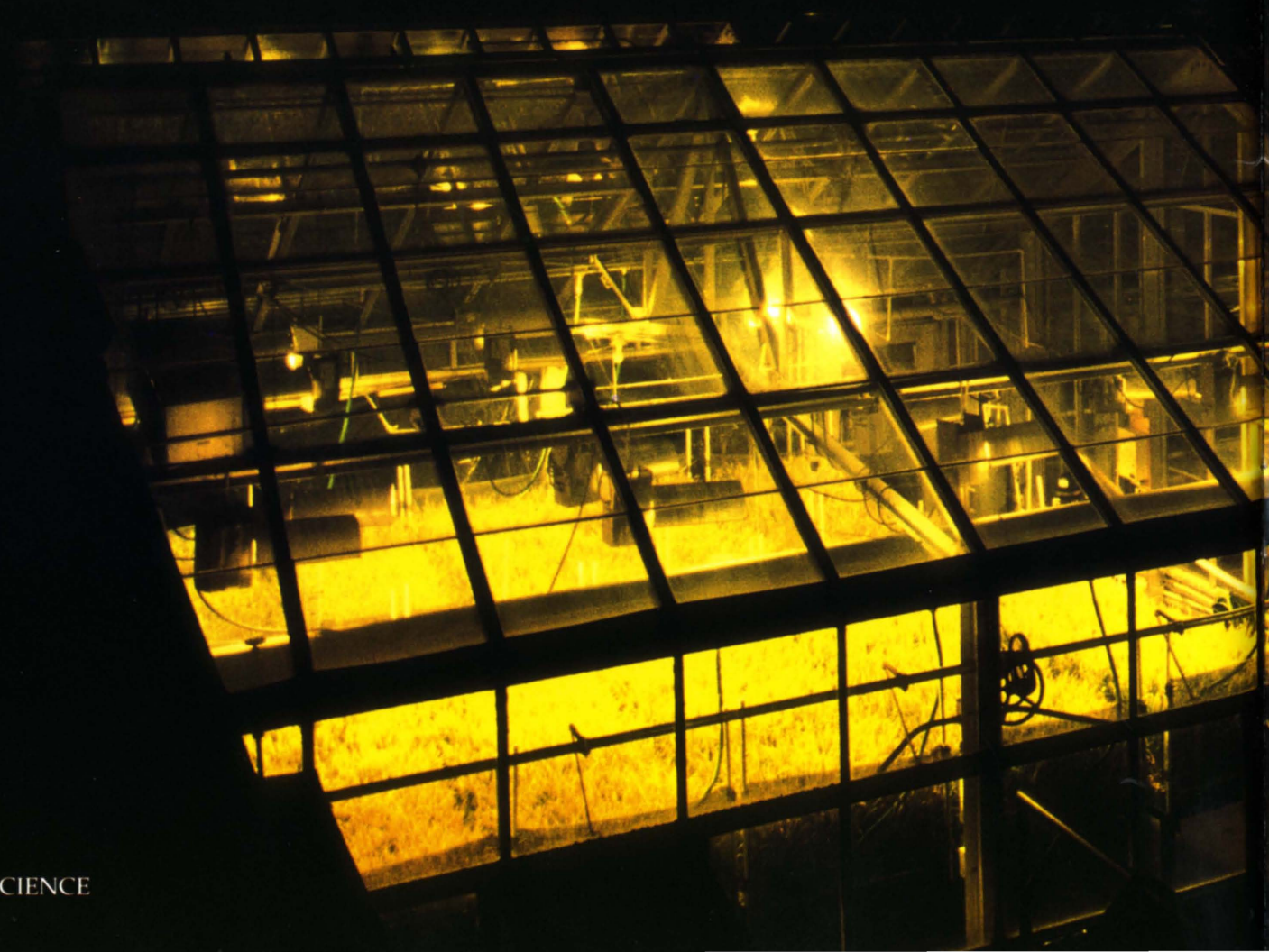
For the past decade, Bugbee, a crop physiologist, has tried to coax ever higher yields from wheat in the quest to build a prototype system for lunar and space farms. Plants warrant such lavish attention because the cost of launching anything into space—humans, widgets, water or wheat—makes it less expensive to rely on lunar-grown wheat than to import food.

Bugbee says the hydroponic system he uses is as trustworthy as any other component of the technological womb that is being fabricated to shelter humans in space. With the premium on reliability,

*Please turn to page 36*

# SPACE WHEAT FARMS

A night view of a USU greenhouse used in space-related wheat research.





**A**s the earth rises and sets on the horizon, plants bathed in high levels of carbon dioxide, artificial light and nutrient-rich hydroponic solutions thrive in the subterranean lunar farm, maturing in half the time required on earth.

By earth standards, it should be possible to produce record yields on lunar farms—an area about 13 square meters should continuously produce enough food for one person. Frank Salisbury, USU plant physiologist who has studied plant growth in a Controlled Ecological Life Support System (CELSS) for more than a decade, sketched

what a lunar farm might look like when he delivered the William A. (Tex) Frazier Lecture at the 87th annual meeting of the American Society for Horticultural Science held Nov. 4, 1990, in Tucson, Ariz.

Production costs will be astronomical on a lunar farm, but they will be far less than shipping meals from earth. And forget those artists' conceptions of lunar farms portrayed under huge glass domes on the moon's surface. A nice idea, but unrealistic, Salisbury said. Transparent domes would not shield occupants from lethal radiation from solar flares, nor would plants fare well during the lunar day,

*Please turn to page 37*

# HOMESTEADING THE MOON





### Space Wheat Farms (cont.)

the embarrassing idiosyncrasies that plagued early hydroponic systems have been corrected. A good thing, too. A minor glitch is alarming when you're several thousand miles from the nearest supermarket.

Frank Salisbury, USU plant physiologist initiated the studies of wheat growth in a Controlled Ecological Life Support System (CELSS).

"We didn't know much about life in the vegetative fast lane when we started in 1981," Bugbee says. "We originally tried hard to shorten the life cycle with continuous light and high temperatures." (The shorter the life cycle, the more efficient the use of limited space.) These alterations reduced the time from planting to harvest from 120 to 60 days, but the tactic backfired. Under that regime, wheat grew rapidly but produced paltry seed yields.

They then reduced the temperature, provided a dark period (4 hours per day) and increased the life cycle to 80 days. Yields increased dramatically. "Since then, we have determined that the increase in yield was due to lower temperatures. Wheat doesn't require a dark period and grows best in continuous light," Bugbee says.

Genetic selection was a key factor. High-yielding varieties in the field were not always suited to the luxuriant, stress-free environment of a CELSS. Most varieties grew so tall that they hit the top of the growth chamber. Foliage-filled growth chambers resembled a jungle. (Density in a CELSS is about 4,000 plants per square meter, about 15 times denser than field plantings).

Jumbo-leaved plants blocked light and flopped over on adjacent plants. Varieties with small erect leaves let more light into the canopy. It now appears that dwarf cultivars are also more photosynthetically efficient because they allocate more photosynthates to the grain. (Larger varieties store them in stems.)

Many wheat-breeding problems have been solved. "The 10 best lines in our breeding program produce higher yields than the best lines from the field," Bugbee says. Space wheat isn't likely to do well on earth, however. The super-dwarf wheat for space is too short—one-third as tall as normal wheat—to compete with weeds and is difficult to harvest and may not fare well against earthly

travails such as drought and disease, in part because taller plants utilize carbon products stored in their stems when they're under stress.

Another troublesome foible is wheat's tendency to produce several shoots (tillers) that develop and mature at different times and delay harvest and reduce yields. Filters that duplicate the natural filtering by chlorophyll molecules in foliage promise to correct the problem.

Roots are bathed in a carefully formulated solution containing all of the 13 essential nutrients (plants obtain three nutrients from the air). The solution is replenished as required. Nothing is discarded.

Researchers have to curb plants' appetite for a few nutrients, which they absorb until levels become toxic. "Plants take up all the manganese within 3 hours after it is added," Bugbee says. A plant would be "force fed" if the concentration of manganese was maintained. A daily dose of manganese prevents this nutritional gluttony.

Wheat grew better when carbon dioxide levels increased from normal levels of 0.03 percent to 0.1 percent; however, a further increase to 0.25 percent was toxic to wheat. "Photosynthetically, carbon dioxide is a highly reactive gas," Bugbee says. (Carbon dioxide levels are toxic to humans only when they exceed 2 percent for a prolonged period.)

Growth chambers are also a microcosm of the earth's ecosystem. Bugbee says we've only now starting to decipher the consequences of centuries of pollution of the earth's atmosphere. If the ecosystem in a growth chamber is unbalanced, the effects would be apparent quickly. "NASA needs to monitor everything in a CELSS because an error could be lethal in a few hours," Bugbee says.

One nagging question concerns the fate of nitrogen. As much as half the nitrogen added to the nutrient solution can't be accounted for by plant growth. The most obvious culprit is anaerobic bacteria, which can convert nitrogen to volatile ammonia. If this much nitrogen is lost in the oxygen-rich root zone of CELSS-grown plants, losses are likely to be higher in the field. Discovering the fate of nitrogen in a CELSS could increase nitrogen recovery in the field.

If these anaerobic bacteria are active in relatively unfavorable conditions, the consequences of any



global warming might be grimmer than anticipated. Soils in northern latitudes contain huge amounts of organic material, whose decomposition has been stalled by cool temperatures. If it warms up, the sluggish anaerobic bacteria could flourish and release massive amounts of climate-altering ammonia to the atmosphere.

Also on the agenda is a more detailed look at "phasic environmental control"—what happens at different stages of plant growth when lighting, temperature nutrient levels and other factors are changed. Currently, the initial temperature of 25°C is gradually reduced to 17°C at harvest, but it might be beneficial to change temperatures more often, perhaps several times during the day. "We can now measure plant response from minute to minute," Bugbee says, which is useful in monitoring a plant's response to an insect nibble, a pulse of light or a host of other factors.

Bugbee is also studying rice and soybeans, two other staples likely to appear on lunar menus. Their growth involves a difficult tradeoff—the dark period required to shorten the life cycle also slows growth. Worse yet, conventional soybean varieties head skyward when they're pampered, reaching heights of more than 7 feet, a problem that may be corrected by short photoperiods, high light intensities, blue light and hormones.

Bugbee and his coworkers revel in gadgetry. "It takes a ton of instrumentation to get the information we need," he says. Pumps, meters, sensors, computers, compressors, fans, filters, lights, ducts, gauges, hygrometers, dataloggers—there are several hundred thousand dollars worth of gadgets, devices, machines, appliances, instruments and utensils in his laboratory. Some are state-of-the-art, others are fabricated with little more than duct tape, silicone caulk and ingenuity.

"When we start to build a system, the wiring makes this place look like a bad day at a spaghetti factory. We construct our growth chambers because we found that it's easier for us to learn engineering than for engineers to learn about biology," Bugbee says.

Some critics question the reliability of plants as a food source in space and favor physical-chemical processes to fabricate food. Bugbee strongly disagrees and cites a Russian experiment that subjected

plants to a simulated lunar rotation equivalent to 14 days of light and 14 days of darkness. Lowering temperatures let plants survive the long night. They then grew during the extended day.

"After a decade of study, we have encountered many of the problems that will occur. The failures are usually caused by equipment, not the plants. Plants are remarkably resilient," Bugbee says.

We have relied on that resiliency for thousands of years. We still will, no matter how far we travel.

KG

Bruce Bugbee 750-2765

### Homesteading the Moon (cont.)

equivalent to more than 29 earth days—about 15 days of darkness and about 14 days of light. Moreover, in the vacuum of space on the lunar surface, it would be extremely difficult to build domes and nearly impossible to keep them pressurized.

The lunar city and farm will probably consist of tubular modules buried several feet under the lunar surface. Individual modules can be rapidly sealed to guard against sudden leaks. (Small leaks are unavoidable, so the atmosphere in the modules has to be continually replenished.)

Salisbury said nuclear reactors might provide the power needed for artificial lights and other purposes. To cut power consumption during the lunar day, huge lenses on the lunar surface will collect sunlight, which will be delivered to plants via fiber optics. This system captures about 60 percent of the light energy striking the lens, far more than the 7-14 percent efficiency of solar cells with batteries.

Chemical reactions can liberate oxygen from the lunar rocks, but carbon (which is virtually nonexistent on the moon) and carbon compounds (including some foods such as meat) must be shipped from earth.

Salisbury says a hydroponic system has several advantages over a soil-based system based on the lunar regolith. Nutrient availability and composition, root zone oxygen and pH can be controlled more accurately, and water stress can be eliminated in a hydroponic system. It pays off. In a properly functioning hydroponic system, roots make up only 3 to 4 percent of the dry biomass of a wheat plant versus 30 to 40 percent of a wheat plant in a field.



It will be essential to recycle as many nutrients as possible, but it's not yet known whether it will be more feasible to recapture nutrients by physically processing wastes (an option if plenty of energy is available) or by relying on biological waste disposal systems (which would tie up valuable carbon).

And what will lunar farms produce? Wheat, certainly. Researchers at other institutions are also intensively studying the production of potatoes, lettuce, soybeans, sweet potatoes and algae in a CELSS. A variety of other legumes, vegetables, grains, fruits and oil crops are also under consideration. It hasn't yet been decided whether to grow and process a few crops, or to grow and process many diverse crops.

While bypassing plants to synthesize food directly from carbon dioxide, water and minerals has appealed to science fiction writers, research has

shown that relying on plants is much less complex and much less expensive.

Salisbury noted that NASA funding of CELSS research has been sporadic and probably totaled less than \$30 million from 1960 through the 1980s, about one-tenth of what it costs to launch a single space shuttle.

Much remains to be learned about lunar farming, including the selection of crops, effects of microgravity, the role of algae, and choosing a source of power.

Salisbury originally anticipated that there might be 250 inhabitants on a lunar city by 2020 A.D., a projection which he says is now "hopelessly optimistic" in view of recent congressional cuts in funding for space-related research.

KG

Frank Salisbury 750-2237

## Guaranteeing the Purity of SEED

**T**oday, shopping malls are stuffed with items that stoke consumer interest. A century or so ago, the hot consumer item was seed.

Seed of a new or improved crop variety was once a bread and butter issue for most Americans. But for decades, the promised gains were diluted by the haphazard production and distribution of seed.

Americans initially took a straightforward approach to the distribution of new varieties—they handed out seed and hoped for the best. For a time, seed from government researchers was even divvied up among Congressmen, who doled out small amounts out to constituents. Supposedly, farmers would plant the new varieties and sell seed to their neighbors.

It didn't work that way. Mislabeling was common. (One selection of oats acquired at least 24 different names.) Seed was contaminated with weeds or different varieties. The potential benefits often vanished after the first harvest.

Matters improved somewhat when agricultural experiment stations parceled seed to graduates from agricultural colleges, but distribution was still uncertain and sporadic. The small amount of seed distributed to each person meant purity during harvest and threshing was problematical. Most cooperating growers were not trained to identify varieties and relied on their own ingenuity and judgment, with mixed results.

In 1919, the International Crop Improvement Association established today's seed certification program. We have reaped the benefits ever since, says Stanford Young, secretary-manager of the Utah Crop Improvement Association, the organization that, in cooperation with the Utah Agricultural Experiment Station and the Utah Department of Agriculture, is responsible for seed certification in the state.

Seed certification sets standards for varietal purity, germinating ability, impurities (including





# Weed Seeds Still A Problem In Noncertified Seed

If you think you don't need certified seed, think again.

You do reap what you sow. And if you sow uncertified seed, you'll be reaping a lot less grain, a lot more weeds, and perhaps other seed of uncertain origin and dubious benefit.

Since 1934, investigators have counted weed seeds in small grains used for seed. Results of the latest survey (1988) show that as many as 75 percent of the farmers may have planted noncertified (common) seed. Fifty-five percent knew they were planting common seed and almost 20 percent of the 450 growers said they planted certified seed, but couldn't produce a tag to confirm the fact, says Steve Dewey, USU Extension weed specialist.

Forty-five percent of the common seed was infested with weeds (an average of 286 weed seeds per pound). The worst sample contained 11,118 weed seeds per pound. Only 3 percent of the certified seed contained weed seeds (an average of 31 weed seeds per pound).

Seventeen percent of the samples contained noxious weed seeds, of which wild oats was the most common. Jointed goatgrass made its initial appearance in the survey, a disappointing but not unexpected arrival. There is no selective herbicide to

control the yield-robbing weed in small grains.

Seeds of spring grain have been grown out to identify varieties. Almost 45 percent of the common seed samples and 21.3 percent of the "claimed certified" varieties (varieties that farmers said were certified but could produce no certification tags to document the claim) contained seeds of another crop. Only 8.2 percent of the certified varieties contained any seeds of another variety, says USU Extension agronomist Ralph Whitesides.

There's also a lot of confusion about the definition of certified seed. Dewey says certified seed requires a tag *in addition to* the seed analysis (purity) tag.

"We are making some headway, but not as much as I would like to see," Dewey says. "Either farmers think that weed seeds don't affect production or they don't realize how much weeds reduce yields. Weed-infested grain seed may not look bad, but on a per acre basis, it's surprising how many weed seeds are planted."

According to the Utah Seed Law, all seed sold, traded, or given away must be accompanied by a purity analysis tag. And there's no such thing as seed that's "as good as certified," or "one year from certification."

Certified seed is certified seed, and has a tag to show it. Survey results provide ample proof of the risks associated with noncertified seed.

The weed survey was conducted by USU Extension agents and district agriculture inspectors with the Utah Department of Agriculture.

KG

Steve Dewey 750-2256

inert matter, weed seeds and seeds of other crops), and seed-borne diseases. The seed origin is verified. The process entails record-keeping, field inspections, laboratory tests and proper labelling. And it's a bargain. Young says certification adds only 10 to 15 percent to the cost of cleaned seed.

In Utah, almost 6,000 acres were entered for certification in 1990, of which 4,400 acres (56 varieties and 29 different crops) eventually met the requirements for certification, including 1,377 acres of barley, 975 acres of wheat, 728 acres of potatoes, 655 acres of alfalfa and 92 acres of oats.

One bright spot is the production of certified grass seed, including many varieties developed and released by the Utah Agricultural Experiment Station and the USDA Forage and Range Research Laboratory. While no certified grass seed was produced in Utah as recently as 1980, 1,517 acres were entered for certification in 1990. Drought cut yields on much of this acreage, but Young estimates that the harvested grass seed was worth over \$200,000 to growers.

KG

Stanford Young 750-2082



**L**ife would be a lot more fruitful if apple orchards became a lot more crowded.

Increasing the density of planting can increase apple yields "more than any other single step a grower can take," says Dave Walker, USU horticulturist. When coupled with the right rootstock and proper orientation (all else being equal, planting trees in rows running north-south instead of east-west can double yields), growers who increase the density of trees to about 400 trees per acre can harvest 1,500 to 1,700 boxes per acre. Walker has had yields that top 3,000 boxes per acre. The average yield in the state is 300 to 400 boxes per acre.

A few decades ago, most apple orchards were thinly populated by today's standards—about 28 trees per acre (a tree in an area 40 by 40 feet). Density at some USU research plots now exceeds 600 trees per acre (a tree every 6 by 12 feet). But that's nothing compared to the "super slender spindle" system now being studied in Europe in which tree density can top 5,000 trees per acre (trees are spaced about a foot apart in rows 8 feet apart).

Utah growers will be hearing more about this type of orchard in which trees are almost as small and flexible as berry bushes. Walker plans to study all aspects of the this and other systems at the experimental orchards in Kaysville.

"The system looks promising," he says.

When Walker and horticulturist J. LaMar Anderson toured orchards in southern Europe last summer, they noted the popularity of the "slender spindle" and other systems in which tree bear fruit the first or second year. None of these planting

systems require ladders. The orchard lifespan is short (about 12 years).

Anderson says a spindle tree looks like a Christmas tree—each is 7 to 8 feet high with a base 3 to 5 feet in diameter that tapers to a point. There are no lateral shoots on the lower 18 inches of the trunk, which facilitates mulching and herbicide applications. Trees are supported by stakes or trellises.

The slender spindle system is widely used in southern Germany where growers plant 1,600 to 2,000 trees per acre and harvest 900 to 1,250 boxes per acre. Growers in Italy usually have 800 to 1,200 trees per acre, but some plan to increase planting density to 3,200 trees per acre.

The slender spindle system is helping European growers cope with extremely high costs. In Germany, for example, growers must have trees that bear fruit within a few years after planting to afford the rent of \$250 an acre annually. Trees on standard rootstocks don't produce well for 6 to 8 years.

USU researchers are evaluating several promising rootstocks for apples, cherries and peaches, many of which are available to growers now. Other research concerns fertilization practices, including the use of monoammonium phosphate and foliar sprays of iron to improve the growth and production of fruit trees.

Walker encourages growers to visit the orchards in Kaysville to learn about these and other promising practices.

KG

LaMar Anderson 750-2236

David Walker 750-2241

## APPLE YIELDS Won't Dwindle with the Slender Spindle

